

THURSDAY, OCTOBER 3, 1901.

## A SCIENTIFIC ENGINEER.

*Papers on Mechanical and Physical Subjects.* By Prof. Osborne Reynolds, F.R.S. Vol. ii. 1881-1900. Pp. xii+740. (London: C. J. Clay and Sons, 1901.) Price 21s. net.

A FULL account of the first volume of Prof. Osborne Reynolds' collected papers has already appeared in these pages (vol. lxii. p. 243). The second volume, which is no less interesting than its predecessor, brings the author's contributions to mechanical science up to date and enables us to realise the value of the work he has done. The twenty-seven papers here printed vary, no doubt, in importance; but throughout them all Prof. Reynolds has kept one aim clearly in view, the application of physical and mechanical principles to engineering problems; whether he is dealing, as in the first paper, with the question of the fundamental limits of speed or, as in the last, with the reasons why ice is slippery, this aim is always before the author.

It is difficult from a volume of this kind to make a selection of points to notice; there are, however, three papers which stand out conspicuously as dealing in a luminous manner with three fundamental problems. The first is No. 44, an experimental investigation of the circumstances which determine whether the motion of water shall be direct or sinuous, and of the law of resistance in parallel channels. The second, No. 52, on the theory of lubrication and its application to Mr. Beauchamp Tower's experiments, and the third, No. 66, on the method, appliances and limits of error in the direct determination of the work expended in raising the temperature of ice-cold water to that of water boiling under a pressure of 29·899 inches of ice-cold mercury in Manchester. A few lines may be given to each of these in turn.

The fact that for narrow tubes and for small velocities the resistance to the flow of water in a tube is proportional to the velocity follows from the experiments of Poiseuille and others. It was also known that this law did not hold in larger tubes or when the velocity was considerably increased, but the cause of the change and the relation of the velocity to the radius for which it occurred in a given tube were unknown until the date of Prof. Reynolds' experiments. He showed that if  $D$  be the diameter of the tube,  $V$  the velocity of the stream and  $P$  the ratio of the coefficient of viscosity to the density, then the change of resistance takes place at a velocity  $V$  given by the equation  $V = P/BD$  when  $B$  is a constant, and, moreover, that at this critical velocity the motion of the water in the tube changes from direct to sinuous; eddies and vortices are set up which are intimately connected with the change in resistance. Further experiments showed that up to the critical velocity the slope of pressure in the tube varies as the velocity, while for velocities considerably greater than the critical the slope of pressure varies as the velocity raised to the power of 1·72.

The second paper deals with Mr. Tower's experiments on lubrication. Mr. Tower had shown that when the

rubbing surfaces, the friction between which was being investigated, were totally immersed in oil, a thin film of oil was formed between them, within which the pressure was enormously greater than in the oil bath; in some cases it was as much as 625 lbs. to the square inch above the pressure in the bath.

Prof. Reynolds gives a very complete account of the existence of this film and of the conditions for complete and incomplete lubrication.

In the last paper mentioned the author gives the theory of a very valuable redetermination of Joule's equivalent.

The laboratory at the Owens College is fitted with a set of triple expansion engines which can be arranged to work on three special hydraulic brake dynamometers, the energy being absorbed by a stream of water which passes through the brake. This water can be taken from a tank holding some 60 tons in a tower 116 feet above the laboratory floor.

The experiment, put briefly, consisted in measuring the work put into the brake, the temperature of the incoming and outflowing water and the quantity of that water. Prof. Reynolds' paper contains a detailed exposition of the theory, with an account of the precautions taken and calculations required to allow for the various sources of error.

The experiments were conducted by Mr. Moorby, and are very closely concordant. It results from them that the mean specific heat of water between freezing and boiling points is 776·94 ft. lbs., or in C.G.S. units 41832000 ergs.

Other papers of great interest and importance might easily be mentioned; for these we must refer the reader to the book itself, at the same time congratulating the author on the conclusion of the task he was asked to undertake and the Cambridge University Press on the service it is rendering to science by its series of reprints of mathematical and physical papers.

## NORTH AMERICAN INSECTS.

*The Insect Book: a Popular Account of the Bees, Wasps, Ants, Grasshoppers, Flies, and other North American Insects, exclusive of the Butterflies, Moths, and Beetles, with full Life-histories, Tables and Bibliographies.* By Leland O. Howard, Ph.D., Chief of the Division of Entomology, U.S. Department of Agriculture. Pp. xxvii+429; 47 plates (plain and coloured), and 264 woodcuts. (New York: Doubleday, Page and Co., 1901.) Price 3 dollars net=12s.

IN the preface to Dr. Holland's admirable "Butterfly Book," the author mentioned that he might subsequently issue a similar work on the moths. The book before us is uniform with Dr. Holland's, who is, as Dr. Howard informs us in his preface, engaged on the promised volume of moths, while another volume on the beetles is in contemplation, we presume by, or under the supervision of, Dr. Howard, though this is not explicitly stated.

Enormous strides have been made in the study of North American entomology during the last forty years, and there must now be a very considerable number of entomologists in the country. No doubt many of these

devote themselves to the popular orders of Lepidoptera and Coleoptera, as in Europe; but nevertheless there are numerous active workers, known or unknown, in all the so-called "neglected orders," and a popular manual on these insects, freely illustrated, must greatly conduce to their more extended study, though it is, of course, impossible to treat of five great orders of insects in a single volume in anything like so complete a manner as Dr. Holland was able to achieve for the limited group of butterflies. Dr. Howard has, however, contrived to bring together and condense a large amount of very useful information from various sources, and his book should prove nearly as valuable to European as to North American entomologists; for not only are a large proportion of the various families and genera common to both countries, but a considerable number even of the species here described and figured are common and well-known British species. Here and there we find a slip, as when the number of described species of Hymenoptera is estimated on the first page as nearly 30,000, whereas it almost certainly exceeds 40,000 at the present time; and at p. 345 the exploded superstition originated by Kirby and Spence that earwigs do *not* enter the human ear seems to be insisted on. Perhaps the rarity of earwigs in the States may partly account for this.

We have already said that some of the species included in this work are common British species. Others are large and handsome forms quite unlike any existing in England, or perhaps in Europe. This is especially the case in the orders Orthoptera and Neuroptera; and the pretty plates of dragonflies, especially plates 40 and 43, representing species with coloured wings, will be something like a revelation to the entomologist familiar only with the hundred European species of dragonflies, not more than three or four of which have any considerable amount of colour in the wings, though this is partly atoned for by the bright colours of their bodies.

Most, if not all, of the figures in the plates are probably original; but most of the text illustrations are copied from Riley, Packard, Comstock and other well-known writers.

As is usual with recent American writers, Dr. Howard admits several more families of insects than the seven with which most of our English entomologists are satisfied. Tables of families are given in several of the orders, which will greatly facilitate the work of a beginner. Otherwise, however, there is little technical matter in the book, which mainly consists of descriptions of habits and transformations. There is a good deal of light readable matter; and Mr. Marlatt's account of the way in which boys in Kansas rob humble-bees' nests by enticing the bees into a jar half filled with water will be equally new and amusing to most English readers.

Turning to the end of the volume, we find a good but not too extensive index of thirteen pages, double columns, preceded by a bibliography of twelve pages, very closely printed in double columns, and arranged systematically in a manner that seems a little puzzling till one gets used to it. This will prove a most useful part of the book to serious workers, and it brings out very forcibly the enormous periodical literature to which Dr. Howard alludes in his preface and which is so conspicuous a feature of the American entomological literature of the

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present day. The bibliography is preceded by a section on "Collecting and Preserving Insects," freely illustrated in the text, like the rest of the book, which, although primarily written for American entomologists, may also furnish useful hints to European collectors.

We cannot do less than strongly recommend Dr. Howard's book to all entomologists who are interested in the orders of insects to which it refers, repeating that the main features of the book are the detailed life-histories and the number of good illustrations of the insects discussed.

#### OUR BOOK SHELF.

*Nature Teaching.* By Francis Watts, F.I.C., F.C.S. Pp. 199. (London: Dulau and Co. Barbados: Bowen and Sons.)

THIS is a very useful volume, issued under the authority of the Imperial Commissioner of Agriculture for the West Indies. It is based upon the general principles of agriculture, and has been designed for the use of schools in the islands. Although these colonies depend entirely on the proper cultivation of the soil, there has hitherto been practically no attempt made to impart to the rising generation a knowledge of even the elements of agriculture. Like everything else in the mother country and in Britain across the seas, the rule of thumb, happy-go-lucky system has been preferred to scientific methods, with the result that we are all being left behind in the race. The Imperial Commissioner notes that one of the most hopeful features connected with the West Indies is the general movement which is now taking place in favour of agricultural teaching. Teachers in charge of schools have during the past three years been undergoing training sufficient to enable them to impart a fair knowledge of botanical principles to their scholars, and the volume now prepared by Mr. Watts, with the assistance of Mr. Maxwell-Lefroy, is intended to guide the teachers in the way they should go. The work is divided into nine chapters, dealing respectively with the seed, the root, the stem, the leaf, the soil, plant food and manures, flowers and fruits, weeds, and insects. Simple language is used in describing each subject, and every chapter ends with copious instructions on practical work. Thus the chapter on the seed deals with the parts of a seed; plant food in seeds; and germination; while under "practical work" we find described the conditions for germination; raising seedlings; seed beds; observations on seedlings; and testing vitality of seeds. A glossary and appendices are added. The book is not intended as an ordinary reading-book, but for the use of the older pupils who have already received oral instruction in the various subjects.

*Cassell's Eyes and No Eyes Series.* Book I. *Wild Life in Woods and Fields.* Pp. 48. Book II. *By Pond and River.* Pp. 48. Book III. *Plant Life in Field and Garden.* Pp. 80. Book IV. *Birds of the Air.* Pp. 79. By Arabella B. Buckley (Mrs. Fisher). (London: Cassell and Co., 1901.) Price, Books I. and II., 4d. each; Books III. and IV., 6d. each.

THESE attractive little books will promote an intelligent interest in plants and animals among the children who read them. In very simple words Mrs. Fisher describes some insects, birds, flowers, and other living things familiar to observers of outdoor nature, and her descriptions will doubtless direct the attention of many pupils to natural history studies. Each book has several nicely coloured plates in addition to numerous other illustrations. In rural schools the books should be of exceptional value.